

# **AUGMENTATION OF WATER SUPPLY SOURCE AND REHABILITATION OF SYSTEM IN URBAN AREAS OF PUDUCHERRY DISTRICT, PUDUCHERRY-PHASE-I**

## **1. THE UNION TERRITORY OF PUDUCHERRY**

The Union Territory of Puducherry was an erstwhile French Colony which consisted of four unconnected regions : Pondicherry (Presently Puducherry), Karaikal, Mahe and Yanam. The same division of four districts has been retained even after the merger of the region with the Indian Territory in the year 1954. The total land area of Union Territory is 492 Km<sup>2</sup> and the population is 12.44 Lakhs as per 2011 census. Today, while Puducherry and Karaikal are embedded with the State of Tamil Nadu, Yanam is an enclave of the State of Andhra Pradesh and Mahe of the State of Kerala. Out of the four regions, Puducherry and Karaikal are the largest ones. (Mahe is the smallest region with an area of mere 9 Km<sup>2</sup>.)

### **1.1 The Need for the study:**

The objective of the project is for augmentation of drinking water supply in Puducherry with per capita water supply of 135 LPCD.

Government of Puducherry has initiated steps to have a comprehensive water supply system study to identify improvements and works required to meet the water supply needs of the city of Puducherry. The water supply study for Puducherry provided the city administration with the required insight and tools to address important water system planning and associated cost issues. These issues include the following:

- i) Immediate action plan for augmentation of water supply source, strengthening, rehabilitation and improvement to water supply system.
- ii) Long term action plan for extension and improvement including augmentation of source.
- iii) The study shall also consider the improvement of the water supply system while keeping in view the future growth in population for the horizon year 2048.

- iv) Identification of ways and means to improve the effectiveness of water supply with regard to its quality, quantity and reliability.
- v) Reduction of the O&M cost in order to achieve an affordable tariff for water so as to improve the service level and cover more unserved and ill-served areas, particularly those falling in low income areas / poor settlements.
- vi) To provide AMR (Automatic Meter Reading) water meters to all consumers.
- vii) To provide SCADA systems in the proposed source augmentation area.
- viii) To provide 3 Nos. of R.O. plants of 5 mld each.
- ix) To provide 5 MLD Water Treatment Plant at Thirukanchi.
- x) To propose 50 MLD Desalination Plant in Second Phase.

## **1.2 Formulating a vision for Puducherry water supply:**

The water supply system study outlines the vision for the growth of the city and details how the city together with stakeholders intends to achieve its long-term vision in the following aspects of water supply:

- Meet the water supply demands of the prospective and ultimate planning years of 2033 and 2048.
- Requirement of ESRs and distribution system to be provided.
- To eliminate all stand posts.
- House connection to urban poor
- Automation and modernization of the water supply systems.
- User charges recovery to 100%.
- Computerization of billing and collection system.
- Capacity building to cope up with Tariff increase.
- Improve the quality of drinking water to high standards.

## **2. PUDUCHERY – THE CAPITAL CITY**

Puducherry, the largest of the four non-contiguous regions, is the capital of the Union Territory, Puducherry lies between 11°45' and 12°50' Northern latitude and between 79°37' and 79°50' Eastern longitude. The city is bounded by the Bay of Bengal on the East and by Villupuram and Cuddalore Districts on all the other remaining sides.

The bulk of Puducherry region is an irregular stretch of land consisting of the municipalities of Pondicherry and Oulgaret and commune panchayats of Ariyankuppam, Villianur, Nettappakkam, Mannadipet and Bahour. The total area of Puducherry region and its eleven enclaves is 293 sq.km with the total population of 9,46,000 according to the 2011 census.

The location of Puducherry makes it a perfect destination for tourists from all over India. It is located at a distance of 135 km from Chennai, the capital city of Tamil Nadu State and about 22 km from Cuddalore in South Arcot District of Tamil Nadu. This can also be reached from Bengaluru in Karnataka.

Besides the main area, the region's eleven enclaves lie scattered within Villupuram, Tindivanam and Cuddalore Taluks. The three isolated enclaves of Mannadipet Commune lie on the North West. One peculiar feature of Mannadipet Commune is that the area surrounding Vadhanur village in Mannadipet main enclave is a mixed territory. Some of the plots in the area belong to Pudhucherry and the others to Tamilnadu. Nettappakkam Commune has one isolated enclave towards the southeast. Villianur has a very small enclave, viz., Manakuppam enclave close to the limits of Nettappakkam Commune.

### **2.1 Physical and Geographical Characteristics**

Puducherry region is a flat country of average elevation of about 15 meters above sea-level, intersected by the deltaic channels of river Gingee, Ponnaiyar and other streams River Gingee and Ponnaiyar forms the two main drainage basins. The region is also interspersed with lakes and tanks. The thick alluvium near Puducherry is indicative of the place having been part of an extensive lagoon. River Gingee crosses

the region diagonally from northwest to southeast. Ponnaiyar forms the southern border. The alluvial delta of Ponnaiyar is only a few meters above the sea. To the northwest of these hills are sections of fossiliferous limestone formations of the Cretacian age. To the south of this area is situated the alluvial tract of Varahanadi (Gingee) and to the north is the recent alluvium.

Puducherry region consists of four geographical zones. The coastal zone comprise of newer and older dunes including saline area of clayey texture. The second zone is made up of the two plateaus called the Puducherry plateau and the Tiruvakkarai plateau composed of a geological formation called the 'Cuddalore Sandstone'. The upper layers are made up of red transported ferralitic soil. The Valudavur plain lies between these two plateaus. Marshy depressions are also frequently encountered in the plains of Valudavur. The flat alluvial zone occupies the rest of the Puducherry region.

## **2.2 Climate:**

Puducherry experiences a hot and tropical maritime type of climate characterized by small daily range of temperature, humid weather and moderate rainfall. The summer season prevails from March to June followed by the period of the southwest monsoon, which lasts upto September. The months of October and November constitute the main northeast monsoon season. The winter season prevails from December to February.

## **2.3 Rainfall:**

The average annual rainfall is of the order of 1270 mm. Of this about 50 per cent is recorded during October – November. November is the rainiest month contributing about 30 per cent of the annual rainfall. The variability of annual rainfall is fairly large and that of seasonal rainfall still larger. In a year there is an average, about 55 rainy days.

## **2.4 Temperature:**

The mean daily temperature ranges from 21°C to 32°C and which may rise to 37°C during hot summer months of April-May and the early parts of June. December and January form the coolest part of the year with the mean daily maximum temperature at about 28°C and the mean daily minimum temperature at about 21°C.

## **2.5 Humidity:**

In view of the coastal location the relative humidity is generally high. It ranges from 50 percent to 75 percent.

## **2.6 Wind Direction:**

Winds are generally light to moderate in velocity during summer and early southwest monsoon season. During southwest monsoon, winds are mostly from south to west. During the summer season, winds are southwesterly or westerly in the morning and southerly or southwesterly in the afternoons. In October and January winds are varied in directions.

## **2.7 Ground Water Table:**

Ground water in the project area is generally found at the shallow depths of 2- 3 m in the coastal areas and 30-40 m in the western parts. The ground water drops by few meters in the lean months.

## **2.8 Linkages and Connectivity:**

**Connectivity by Road:** Puducherry Town is situated on the Eastern side of Puducherry district and is the District Head quarter town. The town has good connectivity with Tamil Nadu State. The East Coast Road connects Puducherry with Chennai. Apart from this the other important roads are NH45A and NH66 which pass through the city.

**Connectivity by Rail:** Puducherry railway station is linked to the nearest junction Villupuram which is 36 km from Puducherry. It is also well connected with Chennai and Thiruvananthapuram. Recently new trains has started from Puducherry connecting Bhuvaneswar city, New Delhi, Howrah, Thirupathi, Mangalore, Dadar (Mumbai) & Yeswanthpur.

**Connectivity by Air:** Puducherry has a medium sized airport, which is connected with Chennai and Bangalore. The Chennai airport is the nearest one to Puducherry which well connected with all cities of India.

## **2.9 Demography:**

The population of Puducherry is 9.74 lakhs as per 2001 Census. As a proportion of the country's total population, it is 0.09%. Women and men constitute exactly 50% of the population (4.87 lakh). The average annual exponential growth rate (1991-2001) of population is 1.87% as against 1.93% for the whole of India. The UT has registered significant reduction in population growth rate in 1991-2001 compared to the previous decade (1981-1991). However during the next decade 2001-2011 there was once again significant increase in population growth rate. Population growth rate in Puducherry is also impacted by migration from Tamil Nadu, Kerala and Andhra Pradesh.

## **2.10 Urbanization**

Puducherry is highly urbanized. Urban population accounts for 69.13% as against the All India proportion of 28% (2011). The average annual rate of growth of urbanization of the UT is 2.77% (2001-2011). Majority of the population of the UT resides in the districts of Pondicherry and Karaikal. In terms of the size of the population, ranking in the descending order is Puducherry, Karaikal, Mahe. No rural population as such in Yanam and Mahe. In Puducherry district, the proportion of rural population is 30.87%. In Karaikal, it is 50.99%.

### **3. URBAN INFRASTRUCTURE IN PUDUCHERRY**

Urban Infrastructure comprises water supply, sewerage and sanitation, storm water drainage, solid waste management and traffic and transportation. The following sections assess urban basic service delivery in Puducherry urban area (comprising of Puducherry municipality, Oulgaret municipality, part of Ariankuppam and Villianur commune panchayats) and sub-project identification based on defined rationale and design criteria.

#### **3.1 Water Supply in Puducherry**

Providing safe drinking water in adequate quantity to the people of Puducherry is the prime endeavor of Public Works Department. Puducherry Public Works Department provides water supply in Puducherry Urban Areas covering Puducherry municipal and Oulgaret municipal area, part of Ariankuppam and Villianur commune. The total water abstracted for supply to Puducherry, Oulgaret municipal areas and in urban areas of Villianur and Ariyankuppam communes is 112 MLD, entirely from the sub surface. There are around 227 bore wells in and around Puducherry.

The entire urban area of the Puducherry has been divided into eighteen zones for the purposes of designing a comprehensive water distribution system.

#### **3.2 Water Treatment:**

Subsurface water is directly pumped from bore wells into sumps and then to overhead tank in respective zones. From Overhead tank water is distributed before pumping to the OHTs. Water is treated with chlorine and also online chlorine dosing done in distribution main to maintain the required residual chlorine. In some areas, the iron content is high and iron removal plant installed.

### 3.3 Water Storage System:

Water supply for eighteen zones is presently provided with 30 Nos. of Overhead Tanks spread across the Zones and by direct pumping . 7 nos of OHT are under construction and 13 nos of OHT are proposed to be constructed in various zones to cope up the intermediate stage. The total capacity of existing, under construction and proposed OHTs, works out to 60.60 ML. With respect to the intermediate demand of 190.84 MLD, storage capacity required is 63.61 ML and with respect to ultimate demand, storage capacity required is 95.70 ML. Since the existing, under construction and proposed OHT capacity is nearing to 63.61 ML, no more OHT will be required for intermediate stage requirement. The list of existing, under construction and proposed are as follows.

#### **List of Over Head Tanks existing, under construction and proposed**

OHT No.	Place of OHT	Capacity of OHT in LL	Status
1.	Kanuvapet	10	Proposed
2.	Uthiravaginipet	10	Proposed
3.	Kombakkam	10	Proposed
4.	Ariyankuppam (Near School)	10	Existing
5.	Ariyankuppam RK Nagar	20	Existing
6.	Sudhana Nagar	20	Under construction
7.	Engineers colony	12	Proposed
8.	Boomiyanpet	10	Existing
9.	Ellapillaichavady	12	Under construction
10.	Thanthai Periyar Nagar	20	Existing
11.	D.R.Nagar	6	Existing
12.	Saram	16	Existing
13.	Savanapet	10	Existing
14.	AFT Mill campus	10	Under construction
15.	Thiyagu Mudaliar Nagar	10	Existing
16.	Viduthalai Nagar	11	Existing

17.	Uppalam	20	Existing
18.	South Zone	20	Existing
19.	Bharathipuram	6	Existing
20.	Rainbow Nagar	11	Existing
21.	Krishna Nagar	20	Existing
22.	Viswanathan Nagar (proposed)	7	Proposed
23.	North Zone	20	Existing
24.	Angalamman Nagar	20	Under construction
25.	Kattamani kuppam	24	Existing
26.	Jayaraman Nagar	15	Proposed
27.	Villianur	20	Proposed
28.	Sulthanpet	10	Proposed
29.	Manavelly	10	Existing
30.	Muthupillaipalayam	6	Existing
31.	Thengaithittu	5	Existing
32.	John Kumar Nagar	10	Proposed
33.	MGR Nagar	10	Existing
34.	R.K.Nagar	10	Existing
35.	Oulgaret school ground	20	Under construction
36.	Sudhagar Nagar	10	Proposed
37.	Elango Adigal School	10	Proposed
38.	Amaithi Nagar	10	Proposed
39.	Dhanabal Nagar	10	Proposed
40.	Anandha Nagar	4.5	Existing
41.	Mettupalayam	10	Existing
42.	Gorimedu , TB Sanitorium	10	Under construction
43.	VVP Nagar	5	Existing
44.	Ashok Nagar, Lawspet	20	Existing
45.	Shanthi Nagar	10	Existing
46.	Karuvadikuppam	10	Under construction

47.	Kurunji Nagar	10	Existing
48.	Govt. quarters- WSP office	5.5	Existing
49.	Indira Nagar, Gorimedu	5	Existing
50.	Kalapet , Alankuppam	15	Existing

### **3.4 Transmission Mains:**

The total length of pumping mains and transmission main is around 31.6 Km. The major transmission main takes off from Muthirapalayam GLSR. There are two CI gravity transmission mains taking off from the GLSR and passing along the Vazhudur – Puducherry road, one of size 14” (350 mm) and the other of size 21” (500mm).

A third CI transmission main of size 8” (200 mm) from the Muthirapalayam pump house passing along Villupuram road near Moolakulam ends at Anna Square.

Another CI transmission main of size 14” (350 mm) takes off from Thirukkanjee head works and passing along Cuddalore Puducherry road feeding the reservoir at Uppalam.

Besides the above distinctive older transmission mains there are other smaller pumping mains between the bore wells and local sumps/overhead tanks with the urban area.

### **3.5. Distribution System:**

The urban and suburban areas were divided into eighteen zones for effective functioning water supply system. The main aim is to provide independent source, storage and distribution for each zone.

The length of distribution network is around 550 Km. There is no water supply treatment plant for the system because the water is subsurface water. The entire system is maintained by PWD.

### **3.6 Service Level:**

Presently the gross water supply is at the rate of 135 lpcd in some areas and below 100 lpcd in most of the areas. Water is supplied 3 times daily and total duration of supply is 10 hours per day. About 90% of the areas are covered by water supply network.

### **3.7 Water Quality:**

Water is regularly tested at the PWD laboratory. Water quality is tested for pH, turbidity, colour, odour and other parameters as per IS10500 – 2012. Residual chlorine in water supplied at consumer point is 0.2 ppm (meeting recommended standards). In general it is observed that the quality of water being supplied by the Public Health Division, PWD can be classified as potable. However in some areas, the iron content and TDS is high and therefore the iron removal plant and community R.O. Plants were installed.

### **3.8 Population Projections**

Population projections are one of the primary criteria for estimating the future water demand of a city. The usual methods of population projections are based on the record of population of previous several decades. Obviously, the reliability of the projection model is dependent on the number of decades of data that is available. Some of the recommended methods of population projection are

- ARITHMETIC MEAN
- GEOMETRIC MEAN
- INCREMENTAL INCREASE
- YEARLY VARIATION
- SEMI LOG (ANALYTICAL)
- WAHID'S ASD METHOD

Using the above methods population estimates for the period of design i.e. 30 years or 3 decades can be made.

### **3.9 Growth Corridors and Densification**

Historically, development of the town was noticed around the existing central area of Boulevard. Muthialpet, Nellithope and Mudaliarpet, Lawspet, Sudhana Nagar, Krishna Nagar, Mahaveer Nagar, Kurinji Nagar, Jayamoorthy Nagar, Reddiarpalayam, J.J. Nagar, Kamban Nagar, Selapapu Nagar, Deva Nagar, Nanbargal Nagar, Pon Nagar, Kalyasundaramoorthy Nagar, Sudhagar Nagar, Vengateswara Nagar, Jayaram Nagar, areas in between ECR and Kamaraj Salai, Moolakulam, Muthirapalayam and Gorimedu areas along N.H. and Vazhudavoor Road, Cuddalore Road and Gorimedu Road etc. are the areas developed subsequently. As in case of most of the cities, Puducherry's growth pattern is also guided along the major transport corridors, which are East Coast road to Chennai, roads towards Tindivanam, Villupuram and Cuddalore. Spatial trend of growth is seen within the Oulgaret Municipal area, Puducherry Municipal area, Ariyankuppam and Villianur commune. Over the recent years, development towards East Coast Road, Cuddalore Road and Tindivanam Road, Vazhudavur Road, Kombakkam-Villianur Road, Villupuram Road and Lawspet – Navakulam Road have gained significance for residential developments.

#### **4. FUTURE DEMAND PROJECTIONS**

The future demand of water depends upon various factors. Some of these are discussed below in order to gain an understanding of the dynamics involved in demand estimations.

As per the CPHEEO manual water demand estimates have to be made for the following three stages:

- (i) Present Demand (2018 A.D – Base year)
- (ii) Intermediate Stage Demand 15 years from Base year 2018 A.D ( 2033)
- (iii) Ultimate Stage Demand 30 years from Base year 2018 A.D ( 2048)

The water demands should include the requirement of water for domestic, instructional, commercial and industrial uses. The Domestic Water Demand needs to be worked out with a per capital rate of supply of 135 lpcd which excludes 15% system losses. The remaining demands should also be calculated as per the provisions in CPHEEO manual. The Institutional and Industrial demands for the futures can be computed based upon the Master Plan of the Municipality.

Since the domestic demand is specified in terms of lpcd, it becomes essential to obtain population projections for the years 2033 and 2048 in order to estimate the water demand. Methods mentioned in 3.9 can be utilized in order to obtain the projected population based upon the census record of the past few decades.

Table (1) presents the population data for Puducherry from the census year 1951 to 2011. Data for Puducherry Municipal limits is available from the year 1981 only.

**Table (1) Population data for Puducherry extracted from Census Reports**

Sl. No	Census year	Puducherry state	Growth rate	Puducherry district	Growth rate	Puducherry project area (urban)	Growth rate
1	1951	3,17,230					
2	1961	3,69,079	16.34				
3	1971	4,71,707	27.81				
4	1981	6,04,471	28.15	4,44,417		2,85,717	
5	1991	8,07,785	33.64	6,08,338	36.88	3,99,244	39.73
6	2001	9,74,345	20.62	7,35,332	20.88	5,05,959	26.73
7	2011	12,44,464	27.72	9,46,600	28.73	6,57,209	29.89

Data presented in the above table can be used for population projections in order to obtain *realistic* values of the domestic demand. Subsequently, provision has to be made for institutional, industrial and commercial demands etc to arrive at the final gross demand.

### **Population Projections**

Data presented in Table (1) is used to obtain population projections for the years 2018, 2033 and 2048. Year 2018 is considered as the design base year, 2033 as the prospective year and 2048 as the ultimate year.

**TABLE 2: DETAILS OF POPULATION AS PER CENSUS**

Area	Year	Population in "Nos"
U.T. of Puducherry (Project Areas)	1981	2,85,717
	1991	3,99,244
	2001	5,05,959
	2011	6,57,209

**TABLE 3: POPULATION GROWTH BY ARITHMETICAL PROGRESSION**

Year	Population in "Nos"	Increment	Percentage Increase
1971 – 1981	2,85,717	-	-
1981 – 1991	3,99,244	1,13,527	39.73
1991 – 2001	5,05,959	1,06,715	26.73
2001 – 2011	6,57,209	1,51,250	29.89
<b>Average</b>		<b>1,23,830</b>	<b>32.12</b>

**POPULATION FORECAST :**

Population in 2011 = 6,57,209 Nos.

Population projection factor in 6 years (2018)  
(Base year for design) =  $(1+0.70 \times 0.3212)$   
= 1.225

Population projection factor in 15 years from  
base year 2018 (2033) =  $(1+1.5 \times 0.3212)$   
= 1.482

Population projection factor in 20 years from  
Base year 2018(2038) =  $(1+2 \times 0.3212)$   
= 1.642

Population projection factor in 30 years from  
base year 2018(2048) =  $(1+3 \times 0.3212)$   
= 1.964

**TABLE 4 : POPULATION GROWTH BY GEOMETRICAL PROGRESSION**

Year	Population in "Nos"	Percentage Increase
1971 – 1981	2,85,717	-
1981 – 1991	3,99,244	39.73
1991 – 2001	5,05,959	26.73
2001 – 2011	6,57,209	29.89

From the **TABLE 4**, the rate of growth [r] per decade between

$$1981 \text{ and } 1991 = 0.3973$$

$$1991 \text{ and } 2001 = 0.2673$$

$$2001 \text{ and } 2011 = 0.2989$$

$$\begin{aligned} \text{Geometric mean 'r'} &= \sqrt[3]{0.3973 \times 0.2673 \times 0.2989} \\ &= 0.3166 \end{aligned}$$

**Population Forecast :**

$$\text{Population in 2011} = 6,57,209$$

$$\begin{aligned} \text{Population projection factor in 6 years (2018)} \\ \text{(Base year for design)} &= (1+0.3166)^{0.7} \\ &= 1.212 \end{aligned}$$

$$\begin{aligned} \text{Population projection factor in 15 years from} \\ \text{Base year 2018 (2033)} &= (1+0.3166)^{1.5} \\ &= 1.511 \end{aligned}$$

Population projection factor in 20 years from  
base year 2018(2038)  $= (1+0.3166)^{2.00}$   
 $= 1.733$

Population projection factor in 30 yrs from  
base year 2018 (2048)  $= (1+0.3166)^{3.00}$   
 $= 2.282$

**TABLE 5: POPULATION GROWTH BY INCREMENTAL INCREASE**

Year	Population in Nos	Increase	Incremental Increase(y)
1971 – 1981	2,85,717	-	-
1981 – 1991	3,99,244	1,13,527	-
1991 – 2001	5,05,959	1,06,715	(-)6,812
2001 – 2011	6,57,209	1,51,250	44,535
<b>Total</b>		<b>3,71,492</b>	<b>37,723</b>
<b>Average</b>		<b>1,23,831</b>	<b>18,862</b>

**Population Forecast :**

Population in 2001  $= 6,57,209$

Population in 6 years (2018)

( base year for design)  $= 6,57,209$   
 $+ 0.7 \times 1,23,831 + (0.7 \times 1.7 \times 18,862)/2$   
 $= 6,57,209 + 86682 + 11223 = 7,55,114.$

Population projection factor in 6 years (2018)

(base year for design)  $= 7,55,114/ 6,57,209$   
 $= 1.149$

Population in 15 years from

$$\begin{aligned} \text{base year 2018 (2033)} &= 6,57,209 + (1.5 \times 1,23,831) + (1.5 \times \\ &\quad 2.5 \times 18,862) / 2 \\ &= 6,57,209 + 1,85,747 + 35,366 \\ &= 8,78,322 \end{aligned}$$

$$\begin{aligned} \text{Population Projection factor in 15 years} & \quad 8,78,322 / 6,57,209 \\ \text{from base year (2033)} & = 1.336 \end{aligned}$$

Population in 20 years from

$$\begin{aligned} \text{base year 2018 (2038)} &= 6,57,209 + (2 \times 1,23,831) + (2 \times 3 \times 18,862) / 2 \\ &= 6,57,209 + 2,47,662 + 56,586 \\ &= 9,61,457 \end{aligned}$$

$$\begin{aligned} \text{Population Projection factor in 20 years} & = \frac{9,61,457}{6,57,209} \\ \text{from base year 2018(2038)} & = 1.463 \end{aligned}$$

Population in 30 years

$$\begin{aligned} \text{from base year 2018(2048)} &= 6,57,209 + (3 \times 1,23,831) + (3 \times 4 \times 18,862) / 2 \\ &= 6,57,209 + 3,71,493 + 1,13,172 \\ &= 11,41,874 \text{ Nos} \end{aligned}$$

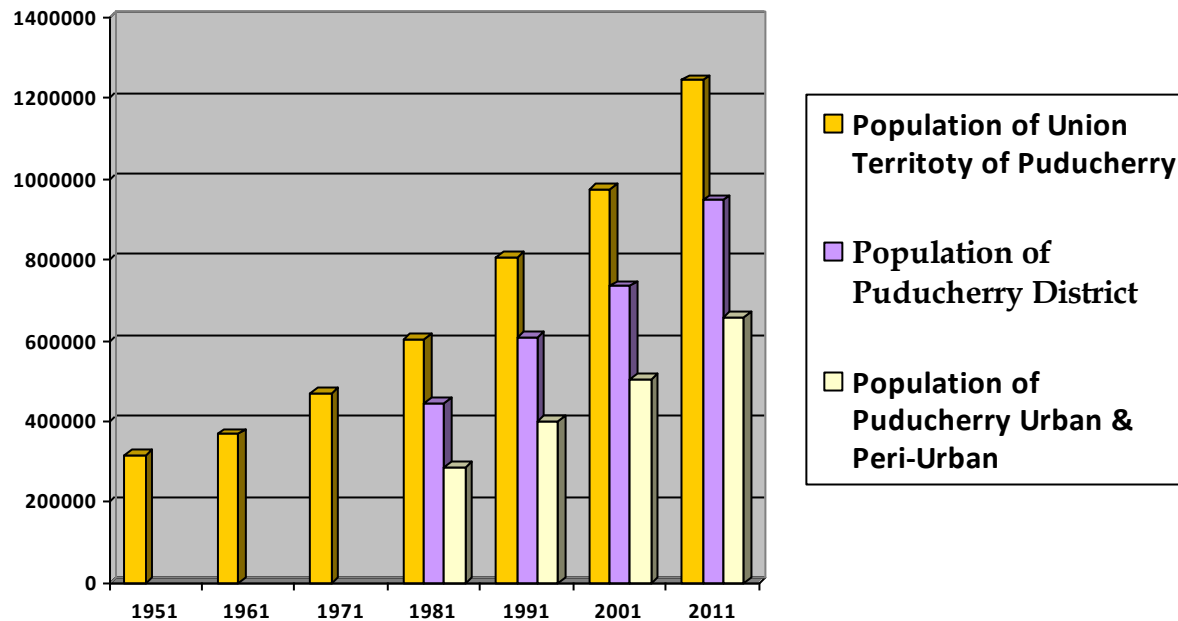
Population Projection factor in 30 years

$$\begin{aligned} \text{from base year 2018(2048)} &= 11,41,874 / 6,57,209 \\ &= 1.737 \end{aligned}$$

**TABLE 6: COMPARISON OF POPULATION PROJECTION FACTORS**

METHOD	PROJECTION FACTOR			
	2018	2037	2038	2048
1.Arithmetical Progression Method.	1.225	1.482	1.642	1.964
2.Geometrical Progression Method.	<b>1.212</b>	<b>1.511</b>	<b>1.733</b>	<b>2.282</b>
3.Incremental Increase Method.	1.149	1.336	1.463	1.737

The data presented in Table (1) is shown in the form era bar chart in Figure (1)



**Figure (1) Graphical Representation of the Population Data**

Table (7) presents the final population projections obtained by various methods outlined in Table 6. The projected population is for the Puducherry urban and peri urban area which constitutes all package areas.

**Table (7)**

<b>Sl. No</b>	<b>Population Projection Method</b>	<b>Estimated Population for 2018</b>	<b>Projected Population for 2033</b>	<b>Projected Population for 2048</b>
1	Arithmetic Mean Method	8,05,081	11,93,130	15,81,179
2	Geometric Mean Method	7,96,537	12,03,567	18,17,697
3	Incremental Increase Method	7,55,133	10,08,857	13,11,666

**Table (8) Final Population projection for the Puducherry urban and Peri urban area in Puducherry**

<b>Sl. No</b>	<b>Year</b>	<b>Population in Lakhs</b>
1	2018	7.96
2	2033	12.03
3	2048	18.17

## Demand Calculations

The water demand for Puducherry is calculated based on per capita consumption of 135 lpcd. This demand is applied to the entire population as per the projections mentioned in Table (8). In addition to this domestic demand, a 15% system loss as per the break-up finished in Table (9) below along with fire demand as envisaged in CPHEEO guidelines is also considered. The 15% system loss is done assuming that leak detection and mitigation are carried out as a part of the plan, in order to warrant a system loss of 15%.

**Table (9) Breakup of the 15% system loss**

<b>Losses</b>	<b>Value</b>
Loss of Water in the distribution system	10 %
Loss of Water in the whaler transmission	2 %
Loss of Water in the treatment process	2 %
Loss of water in the raw water Transmission	1 %

The computed demand for the year 2013, design year of 2018, prospective year 2033 and ultimate year 2048 is presented in Table (10) to Table (13).

**Table (10) : PRESENT DEMAND ON 2013 :**

<b>Description</b>	<b>Population</b>	<b>Unit</b>	<b>LPCD</b>	<b>Calculation</b>	<b>Total in MLD</b>
<i>Demand for 100% population</i>	6,94,670	Nos	135		93.780
Fire demand				$(100\sqrt{694.670})/1000$	2.636
Unaccounted for water (15%)				$96.416 \times 0.15$	14.462
<b>Total</b>					<b>110.878</b>

**Table (11) : DESIGN DEMAND (2018)**

<b>Description</b>	<b>Population</b>	<b>Unit</b>	<b>LPCD</b>	<b>Calculation</b>	<b>Total in MLD</b>
<i>Demand for 100% population</i>	7,96,537	Nos	135		107.528
Fire demand				$(100\sqrt{796.537})/1000$	2.822
Unaccounted for water (15%)				110.35	16.552
<b>Total</b>					<b>126.902</b>

**Table (12) : INTERMEDIATE DEMAND ( 2033 ) :**

<b>Description</b>	<b>Population</b>	<b>Unit</b>	<b>LPCD</b>	<b>Calculation</b>	<b>Total in MLD</b>
Demand for 100% population	12,03,567	Nos	135		162.482
Fire demand				$(100\sqrt{1203.567})/1000$	3.469
Unaccounted for water (15%)				$165.951 \times 0.15$	24.893
<b>Total</b>					<b>190.844</b>

**Table (13) : ULTIMATE DEMAND ( 2048 ) :**

<b>Description</b>	<b>Population</b>	<b>Unit</b>	<b>LPCD</b>	<b>Calculation</b>	<b>Total in MLD</b>
Demand for 100% population	18,17,697	Nos	135		245.389
Fire demand				$(100\sqrt{1817.697})/1000$	4.263
Unaccounted for water (15%)				$249.652 \times 0.15$	37.448
<b>Total</b>					<b>287.10</b>

**Table (14) Splitup population projection for all zones in Puducherry Urban and Peri urban areas**

	<b>Zone Details</b>	<b>2011</b>	<b>2018 (Base year)</b>	<b>2033(Intermedite year)</b>	<b>2048 (Ultimate)</b>
Zone-1	Puducherry Town	74,000	89,688	1,18,400	1,40,600
Zone-2	Muthialpet	63,526	76,994	1,04,818	1,33,405
Zone-3	Nellithope	73,666	89,283	1,21,549	1,54,699
Zone-4	Mudaliarpet	60,041	72,770	1,05,072	1,32,090
Zone-5	Lawspet	59,260	71,823	1,09,631	1,42,224
Zone-6	Thattanchavady	42,216	51,166	69,656	88,654
Zone-7	Muthirapalayam	31,640	38,348	68,026	87,959
Zone-8	Moolakulam	49,099	59,508	98,198	1,37,477
Zone-9	Reddiarpalayam	30,688	37,194	61,069	85,926
Zone-10	Sudhana Nagar	26,262	31,830	54,625	70,907
Zone-11	Kombakkam Ottampalayam	10,590	12,835	21,921	30,711
Zone-12	Villianur	16,354	19,821	37,614	52,333
Zone-13	Uthiravahinipet, Kanuvapet	19,660	23,828	37,354	51,116
Zone-14	Ariyankuppam	43,480	52,698	86,960	1,26,092
Zone-15	Velrampet	15,748	19,087	29,685	47,244
Zone-16	Sulthanpet	14,128	17,123	29,245	36,733
Zone-17	Manavely, Thattanchavady	12,029	14,579	22,855	33,681
Zone-18	Periakalpet, Alankuppam	14,822	17,964	26,672	38,595
	Newly developing area as per Master plan				2,30,023
	<b>Total</b>	<b>6,57,209</b>	<b>7,96,537</b>	<b>12,03,350</b>	<b>18,20,469</b>

**Table (15) Computation of total demand for the design, prospective and ultimate years for Puducherry Urban and Peri urban areas**

<b>Sl. No</b>	<b>Year</b>	<b>Population in Lakhs</b>	<b>Demand in MLD at the rate of 135 lpcd</b>	<b>Fire demand (MLD)</b>	<b>15 % system Loss (MLD)</b>	<b>Total Demand in MLD</b>
1	2018	7.965	107.528	2.822	16.552	126.902
2	2033	12.035	162.482	3.469	24.893	190.844
3	2048	18.176	245.389	4.263	37.448	287.10

### **Deficit in Supply Levels**

The total supply at present (2015), from 227 bore wells is 108 MLD. Table (15) presents statistics pertaining to the deficit in the supply levels for the design year 2018, the prospective year 2033 and the ultimate year 2048.

**Table (16) Deficit in MLD for the years 2018, 2033 and 2048 for Puducherry Urban and Peri urban areas**

<b>Sl. No</b>	<b>Year</b>	<b>Demand in MLD</b>	<b>Present Supply in MLD(2015)</b>	<b>Deficit in MLD</b>
1	2018	126.902	112.00	14.902
2	2033	190.844		78.844
3	2048	287.10		175.10

Due to non availability of a reliable surface source, the town is dependent entirely on ground water in order to meet the water supply demand. The total deficit for the base year 2018 is 14.90 MLD, for the prospective year 2033 it is 78.84 MLD and for the ultimate year it is 175.10 MLD. Hence it is observed that over a thirty years period, the supply has to be increased by 2.5 times in order to meet the demand. It is therefore imperative that source augmentation has to be done in phased manner with the eventual goal of realizing 287.10 MLD supply in the year 2048.

## **5. METHODOLOGY**

The Detailed Project Report for Augmentation of water supply and rehabilitation of systems in urban areas of Puducherry District had been developed in confirmation with the relevant BIS and CPHEEO guidelines. Given below is a brief outline of the proposed methodology for accomplishing this task.

### **5.1 Water Supply – A General Outlook:**

Equitable water distribution to the consumers is the most critical component of the present water supply system in Puducherry have been addressed seriously in this report to allow more users to use the existing and proposed system and their downstream facilities.

While reviewing the performance of the existing system, the works that need to be taken up to enable equitable distribution of available after with adequate pressures till the year 2048, have been identified.

In view of the above, an extensive field work to assess the general hydraulics in various distribution zones and also completed the work of updating the distribution system drawings. Based on these updated drawings and the field measurement data, the zonal distribution system and conceptualized the strengthening required in the water supply system.

At present the Puducherry urban area is divided into eighteen zones for the purpose of water supply. It is proposed to retain the existing division as it is well entrenched.

### **5.2 Study of the existing supply regime:**

At present, the citizens of Puducherry are being supplied water for 10 hours a day. Now the water supply is at the rate of 135 LPCD in some areas and below 100 LPCD in most areas. And also, there are certain newly developed pockets which is having inadequate pressure to supply. They augmentation scheme project is aimed not

only for strengthening the supply system in the core area, but is also intended to implement the scheme in new areas. In the long term, it is desirable to implement 24 x 7 water supply for the entire urban area.

The pipes having low carrying capacities are proposed to be strengthened by laying of parallel pipes of DI of suitable sizes.

### **5.3 Consumer connections:**

There are totally 1,00,000 House service connections. Consumer connections are often the major source of leakage. As part of the Leak Detection Programme, the pipelines and consumer connections will be tested and those consumer connections found leaking will be replaced by pipes of acceptable specifications and standards as recommended by CPHEEO manual.

### **5.4 Design of pipe networks**

The problem of design of pipe network essentially involves determination of the minimum permissible sizes, restriction to commercially available sizes, and mainly minimum residual pressure requirements at critical nodes. The total cost of the network is generally assumed to include the cost of the pipes, pumps and other components and the present value of the maintenance and operating costs. Several approaches have been suggested for handling this economic design problem over the years. Distribution network design software such EPANET, WaterGem, LOOP were used for analyzing the hydraulics of pipes.

### **5.5 Selection of pipe material**

It is proposed to adopt the type of pipe taking into following aspects into consideration.

- Availability
- Economics
- Durability
- Soil conditions
- Roughness Coefficient
- O&M considerations

## **5.6 System improvement and augmentation studies:**

Studies has been made for the improvement and augmentation of the system for the following unit operations:

- Source augmentation
- Feeder mains
- Pump houses
- R.O. plants
- Water Treatment Plant
- AMR metering to all consumers
- SCADA system.

## **5.7 Embracing of new Approach**

The new source augmentation makes better economic sense to ensure that the existing water supplies available are used in the most efficient ways. This will reduce water demand and allow current limited resources to be stretched to the fullest extent. To make every drop count, the City has to adopt an integrated approach for efficient water us. This approach encompasses not only ensuring that Puducherry water supply network Infrastructure is efficiently operated but also water demand is well managed through measures like water conservation. Public education, tariffs and legislation to encourage customers to use water efficiently within their premises.

## **5.8. Recommendations for improvement and rehabilitation :**

The deficiencies in the present operation of water supply system has been examined and the following upgradation/rehabilitation works are suggested.

- Source augmentation
- Collection wells
- Master collection well
- Feeder mains from Thirukanchi
- R.O. Plants
- Water Treatment Plant
- A.M.R. metering system
- SCADA system

## 6. PROJECT DETAILS

The City of Puducherry lacks substantial surface water sources and hence the entire domestic water demand of the city is met from ground water sources through a series of tubewells constructed under comprehensive urban water supply schemes. At present, water extracted from about 227 tube wells is being used to meet the domestic water demand of the Puducherry urban and peri-urban area.

### 6.1 Water Supply zones:

In order to optimize the resource allocation and implement efficient O&M practices, it is necessary to divide the urban area into zones. These zones will be technically as well as administratively independent of each other. The zonal plans are usually developed based on the topography of the area.

The entire urban and peri urban areas of Puducherry city are divided into 18 zones for the purpose of designing comprehensive water supply system. Figure below shows the 18 zones of Puducherry Urban and Peri-Urban area.

The following are the 18 zones divided for efficient O&M management and to stabilize the residual pressure evenly everywhere.

1. Zone 1 Puducherry Town
2. Zone 2 Muthialpet
3. Zone 3 Nellithope
4. Zone 4 Mudaliarpet
5. Zone 5 Lawspet
6. Zone 6 Thattanchavady
7. Zone 7 Muthirapalayam
8. Zone 8 Moolakulam
9. Zone 9 Reddiarpalayam
10. Zone 10 Sudhana Nagar
11. Zone 11 Kombakkam, Ottampalayam
12. Zone 12 Villianur
13. Zone 13 Uthiravahinipet, Kanuvapet

14. Zone 14 Ariyankuppam
15. Zone 15 Velrampet
16. Zone 16 Suthanpet
17. Zone 17 Manvely, Thattanchavady
18. Zone 18 Periakalapet, Alankuppam.

## 6.2 Present water supply status and need for proposed schemes

The rapid development there were fast out growth and new colonies sprung up in the periphery of the commissioned Zones. The Government of Puducherry has to assure the minimum needs of drinking water to all growing and old areas. However due to this haphazard extension of distribution grid in the out growth areas, the required residual pressure at the designed distribution grid also cannot be achieved. Therefore, extensive survey of these was completed and in this Detailed Project Report augmentation scheme for these zones were included.

At present the PWD is supplying 108 MLD from the groundwater source of 227 borewells. While investigating the quality parameters from these borewells, it was observed that the TDS is >500 ppm in 123 borewells and nitrate content is higher in 33 borewells. Therefore, totally 156 borewells is going to be abandoned gradually. In order to bridge the gap between supply and gap 3 Nos. of RO plants are proposed. After abandoning these borewells, the yield from available 71 borewells, out of 227 borewells, will be 33.864 MLD.

### Demand gap match

As per intermediate demand, the gap will be 190.844 MLD from Table No.15.

Total intermediate demand	.. 190.84 MLD
Yield from 71 borewells	.. 33.864 MLD
Yield from the proposed 84 Nos. New borewells	.. 108.400 MLD
Supply from 3 Nos. of proposed RO plants	.. 15.000 MLD
	-----
	157.264 MLD
	-----

Short fall 33.576 MLD (190.84 – 157.264)

Total demand short fall 33.576 MLD

Therefore it is proposed 30 mld desalination plant in the II phase.

Further to utilize the surface water at Sankarabharani River, a 5 MLD Water Treatment Plant was proposed at Thirukanchi.

### **6.3 Source augmentation from distance sources to Master Collection Well at Thirukanchi.**

#### **6.3.1 Construction of new tube wells (84 Nos.)**

The required 84 Nos. of tube wells shall be constructed at various locations in Puducherry rural areas for a depth of 60m. All the wells will be provided with 25 HP submersible pumpset with 100 KVA DG set. The pumpsets were provided with variable frequency drive. Proposals were also given to construct 8 x 5 m pump house with electrification.

The groundwater from these tube wells will be conveyed through 200mm dia to 300 mm dia DI pipeline to 5 Nos. of collection wells and details are explained in subsequent paragraphs.

The level, flow and pressure of these tube wells can be monitored through SCADA system at respective collection well.

#### **Drawal of Ground water from Tube wells :**

No of Tube wells to be constructed : 84 Nos

Yield expected from Twelve tube wells : 50000 LPH

Yield expected from Seventy two tube wells : 60000 LPH

Hours of Pumping : 22 Hours

Quantity will be drawn from 12 Tubewells : 50000 x 12 x 22 = 13.2 MLD

Quantity will be drawn from 72 Tubewells : 60000 x 72 x 22 = 95.2 MLD

**Total quantity for 84 Tubewells = 108.4 MLD**

### **6.3.2 Construction of collection wells (5 Nos.)**

Five numbers of collection wells are to be constructed in the following places:-

- 1) Collection well – Sivaranthagam ( 18 Nos tubewells) – Dia 15.6m – Depth 4.5m
- 2) Collection well - Keela sathamangalam ( 16 Nos) – Dia 15.8 – Depth 4 m
- 3) Collection well - Puthukuppam ( 22 Nos tubewells) – Dia 17.6 – Depth 4.5 m
- 4) Collection well - Korkkadu ( 12 Nos tubewells) – Dia 18.1 – Depth 4.5
- 5) Collection well – Mangalam (5 Nos tubewells 4800 cum/d) – Dia 11.3 – Depth 4 m.

Master collection well at Thirukanchi to cater the required quantity of 108.40 MLD. Rate of Pumping by considering 22 hours.

All the collection wells provided with 3 Nos. of 40 HP centrifugal pumpsets with 2 Nos. working and 1 standby. DG set is also provided with a capacity of 160 KV. The pressure water from these collection wells will be conveyed to Master collection well through 500 to 1000mm dia DI pipeline. The level, inlet flow, outlet flow and pressure can be monitored through SCADA system at Master Collection Well.

Provision has also been made for construction of pump room of six 12 x 6m at each collection well with a compound wall.

### **6.3.3 Master Collection Well ( 1 No.)**

One number of Master Collection well is proposed at Thirukanchi to receive 84.04 MLD of water from 5 Nos. of collection wells.

The size of the master collection well in rectangular size of 36 x 24 x 4.5m.

This master collection well was provided with 5 Nos. of 150 HP centrifugal pumpset with 3 Nos. working and 2 Nos. standby. DG set is also provided with 1000 KVA capacity. Pump room of size 15 x 9m with a compound wall are proposed.

All the operations of 84 Nos. of tube wells, 5 Nos. of collection wells and 1 No. of Master collection well can be controlled at one location and also can be monitored at 10 other locations.

#### **6.4 Feeder mains from Master collection well at Thirukanchi to 35 SRs.**

It is proposed to lay feeder mains from the master collection well at Thirukanchi to 35 surface reservoirs at various locations. This feeder main of DI pipe size varies from 1000 mm to 200mm.

#### **6.5 R.O. Plant (3 Nos. )**

It is proposed to construct 3 Nos. of R.O. plants of 5 mld capacity each at Thirukanchi, Sudhana Nagar and Swadhesi cotton mill OHT campus.

The quality of water mainly TDS drawn from subsurface source increasing slowly and it is nearing to the undesirable limit for drinking. Therefore to treat this TDS it is proposed to construct 3 Nos. of R.O. plants. The treated water will have TDS in the order of 50 to 100 ppm. This treated water will be blended with fresh water from tube wells so that allowable limit is not exceeded.

The following components were included in the R.O. Plant.

- a) Raw water collection tank
- b) Pressure sand filter
- c) Micro filter
- e) Dosing tank

The raw water characteristics is pH 6.5 – 7, TDS 3282 ppm and the R.O. permeate characteristics is pH 5.5 to 6, TDS <90.

#### **6.6 5 MLD Water Treatment Plant at Thirukanchi**

It is proposed to construct a 5 MLD Water Treatment Plant at Thirukanchi by drawing surface water from Sankarabharani River.

#### **6.7 Distribution grid, pumping main and Road restoration for Sudhana Nagar (Zone-10)**

The scheme area covers Sudhana Nagar, Nainar Mandapam, Murungapakkam and other adjoining areas for which a comprehensive water supply scheme is proposed. The scheme area covers over 210 Hectares approximately.

The areas that are to be covered are as follows :

- 1 Sudhana Nagar
- 2 Kargil Nagar
- 3 Thirumagal Nagar
- 4 Anand Nagar
- 5 Bharathiyar nagar
- 6 Ganapathy Nagar
- 7 Nehru nagar
- 8 Vasanth Nagar
- 9 Aravindar Nagar
- 10 Ramanujar Nagar
- 11 Maraimalai Nagar
- 12 Mugambigai Nagar
- 13 Vallalar Nagar
- 14 Angalamman Nagar
- 15 Thivan Kanthappa Mudalyar Nagar
- 16 Health Employees Colony
- 17 Murungapakkam
- 18 Thulukanathamman Nagar
- 19 Makkal Nagar

#### **6.8 OHT, sump, Distribution grid, pumping main and Road restoration for Villianur (Zone-12)**

The scheme area covers Padmini Nagar, Pandian Nagar, Saraswathi Nagar, Moorthi Nagar, Thirukameswarar Nagar, Thillai Nagar and other adjoining areas for which a comprehensive water supply scheme is proposed now. The scheme area covers over 140 Hectares approximately.

Villianur and adjoining area spread over a large area and hence it is proposed to construct the overhead tank with staging height of 18.90m & 27.00m so that the OHT and the distribution systems ensure adequate terminal pressure at the tail end also.

The areas that are to be covered under this scheme are as follows :

1. Padmini Nagar
2. Perumal Nagar
3. Brindavanam Nagar
4. Pazhanisami Nagar
5. Pandian Nagar
6. Om sakthi Nagar
7. Moorthi Nagar
8. Annai Nagar
9. Krishna Nagar
10. Saraswathi Nagar
11. Siva Ganapathi Nagar
12. Sundaramoorthi Vinayagapuram
13. Kaveri Nagar
14. Kannagi Nagar
15. Nathan Nagar
16. Mangalammal Nagar
17. Sathiya Nagar
18. Vasantham Nagar
19. Thirukameswarar Nagar
20. Thillai Nagar
21. Thillai Nagar Garden
22. Veeravanchi Nagar
23. Kogilambigai Nagar

## **6.9 OHT, sump, Distribution grid, pumping main and Road restoration for Uthiravahinipet and Kanuvapet (Zone-13)**

The scheme area covers Kanuvapet, Uthiravahinipet, Pudhunagar, Pudhupet, Valluvanpet, Periapet, S.S.Nagar and other adjoining areas for which a comprehensive water supply scheme is proposed. The scheme area covers over 220 Hectares approximately.

Kanuvapet, Uthiravahinipet, Pudhunagar, Pudhupet, Valluvanpet, Periapet, S.S.Nagar and adjoining area spread over a large area and hence it is proposed to construct the overhead with staging height of 24m so that the OHT and the distribution systems ensure adequate terminal pressure at the tail end.

The areas that are to be covered under this scheme are as follows :

1. Kanuvapet
2. Pudhunagar
3. Uthiravahinipet
4. Pudhupet
5. Valluvanpet
6. S.S.Nagar
7. Lourdu Nagar
8. Aurobindo win city
9. Sri Ram Nagar
10. Tamilarasi Nagar

## **6.10 Distribution grid, pumping main and Road restoration for Dr.Radhakrishnan Nagar (Zone-8 extension)**

The area in this part is Zone-VIII (Moolakulam). All the components in the scheme area where already completed by utilizing state fund.

The completed components along with double ducker OHT commissioned and presently water is distributed through the existing grid. The existing grid was executed under minor extension by municipality, Commune Panchayats in a haphazard manner without proper design and hence adequate terminal pressure is not achieved even though the staging height of OHT is 18m and 25.8m. Hence it is proposed to execute the properly designed distribution grid in this package.

The scheme area covers over 335 hectares approximately. Dr. Radhkrishnan Nagar, GN Palayam, Muthupillaipalayam and adjoining areas spread over large area and hence already double decker over head tank with staging height of 18m and 25.8m have been constructed so that bottom decker can be connected to the nearby area around the OHT and the top decker can be connected to area at longer distance from the OHT with separate dedicated line in order to ensure adequate terminal pressure at the tail end and equalization of distribution system. Accordingly the distribution grid was designed.

The areas that are to be covered under this scheme are as follows.

- 1) Dr. Radhakrishna nagar
- 2) G.N palayam
- 3) Vasantham Nagar
- 4) Moolakulam (partially)
- 5) Thiru Nagar
- 6) Ezahil Nagar
- 7) Thirukuralar Nagar
- 8) Paris Nagar
- 9) Thirumalai Thayar Nagar
- 10) Adikesavan Nagar
- 11) Pavendan Nagar
- 12) Roja Nagar
- 13) Shanmugam Nagar
- 14) Om Sakthi Nagar
- 15) Gopalankadai main Road

- 16) Sri balaji Nagar
- 17) Indira Nagar
- 18) Pudu nagar
- 19) Nadarajan Nagar
- 20) Valliamai Nagar
- 21) Vennisamy Nagar
- 22) Bharathidasan Nagar

### **6.11 OHT, sump, Distribution grid, pumping main and Road restoration for Sulthanpet (Zone-16)**

Sulthanpet is located on the west of Puducherry town at about 7Kms. Adjacent to Sulthanpet many of new colonies have sprung up recently due to urbanization and industrialation. At present the water supply is being effected through small sized OHT's and by direct pumping. The present source is found to be inadequate to fulfill the demand of the people. The scheme area of Sulthanpet covers over 165 hectares approximately.

The scheme covers the following 39 habitations in and around sulthanpet .

- 1) Sulthanpet
- 2) Mohammadhiya Nagar
- 3) Thendral Nagar
- 4) Anbu Nagar
- 5) A.R.R Nagar
- 6) A.N.S Nagar
- 7) Raja Nagar
- 8) Arasur
- 9) Arun Nagar
- 10) A.R.R Nagar (Extension)
- 11) Thaquwa Nagar
- 12) Vetrivel Nagar
- 13) Thavala pet

- 14) Madhina Nagar
- 15) Raja Nagar (Extension)
- 16) Three star Nagar
- 17) Five Star nagar
- 18) Abdhul Kalam Nagar
- 19) Jahir Hussain Nagar
- 20) Valarpirai Nagar
- 21) Tippu Sulthan Nagar
- 22) M.N.R Nagar
- 23) Vengateswara Nagar
- 24) Vennisamy Nagar
- 25) G.N. Palayam
- 26) Ohm Sakthi nagar
- 27) Muthamizh Nagar
- 28) Sapthagiri Royal city
- 29) Muthupillaipalayam Part
- 30) Mahalakshmi Nagar
- 31) Mahalakshmi Nagar (Extension)
- 32) Ambal Nagar
- 33) Tagore Nagar
- 34) Ameed Nagar
- 35) Agallier Nagar
- 36) JMJ Nagar
- 37) Raghuman Nagar
- 38) Vageethu Nagar
- 39) Arasur pet

## 6.12 Technical details of augmentation components

### Pumping main and common main :-

It is proposed to pump the tube well water directly by providing submersible pumpsets to the sump, proposed at OHT campus through the pumping main and common main. According to the tube well location in the individual zones single pumping main or common main by combining two or more tube wells where proposed to reduce the initial infrastructure cost. All the pumping main and common main where designed as a economical size as per the model calculation provided in the CPHEEO manual. Necessary air valves and sluice valves along the pumping main and common main also provided. The detailed calculation of each pumping main and common main is provided in the individual package / Zone volumes. The capacity of submersible motor at tube well where also arrived at based on the pumping head and friction losses required by pumping / common main and presented in all packages.

### Over head tank and sump :-

For each proposed zones, the required capacity of over head tank and sump was proposed individually without combining each other. The water from the tube well sites will be pumped to sump at over head tank site. The sump will act as a buffer between pumping from tube well site and OHT. Then water is pumped to OHT by centrifugal motor pumpsets provided at OHT site pumphouse. 33% standby centrifugal motor pumpset are also proposed. The capacity of OHT for each proposed zones are worked as a balancing reservoir considering the intermediate demand for the zone. However the capacity of OHT was also restricted to 33% of intermediate demand. The capacity of sump was arrived considering 12 hrs pumping from tubewells and 1.5 hours detention time of the intermediate demand. However practically to face any untoward situation such as tubewell failure, pumpset failure, pumping main bursting etc the higher capacity sump is required which can handle higher buffer. The detailed capacity calculation of OHT and sump is provided in individual package / zone volumes. The staging height of over head tank was fixed, such that the terminal residual pressure of 12m was achieved, at the same time the cost of distribution grid was minimized by providing smaller diameter pipes.

### **Distribution grid and house service connection:-**

As the Ductile iron pipes are non corrosive, weight less, easy to handle, easy to work, easy to lay with rubber gasket, less cost compared to CI pipes, with stand high pressure, ductile non brittle and manufactured under thorough quality surveillance it is proposed to use ductile iron of K7 class pipes for distribution grid. The distribution grid was designed with EPANET Software for each zone and presented in each volumes separately. Due care has been taken to use minimum diameter pipes at the same the time, required residual pressure is achieved, so that the overall cost of distribution grid is kept minimum. The minimum terminal residual pressure is fixed as 12m as per CPHEEO guidelines to satisfy the double storied house. Initially the distribution grid was designed in Loop version 4.00 which can give the economical pipe diameter and then data feed into EPANET and designed in which terminal pressure, velocity, pipe diameter, connectivity etc can be checked visual in the computer screen which is not possible in loop version 4.00. The distribution of node demand was also scientifically calculated and feed in to EPANET, so that design values are more accurate. MDPE house service connection pipe of 15mm dia with required fittings and brackets to take connection from the distribution grid was proposed. Provision was also made for water meter to reduce UFN / NRW.

### **Pumpsets, generators and power connection:-**

At all to tube well site submersible pumpsets of capacity 15 H.P to 25 H.P was proposed in all schemes according to the calculation. At the existing tube well sites the existing submersible pumpsets will be replaced with the designed capacity. To ensure uninterrupted water supply to the public, generators are required at all tube well site pump houses and at OHT site pumphouse. Since all the tube well site and OHT sites are situated within the residential area, acoustic proof generators are proposed in the detailed estimate of each zones. The provide the required power connection, recently Electricity department is insisting the PWD to provide transformers and therefore necessary provision for transformers are also provided in the detailed estimate of zones.

**Road restoration and miscellaneous item:-**

The bitumen road, concrete road, WBM road which was cut open during laying of pumping main and distribution grid has to be restored. Therefore necessary provision for all road restoration has been provided in the detailed estimate. Provision for internal electrification at pump houses, electronic level indicators, bulk meters, protection wall at OHT sites, SCADA systems, scientific equipments and inspection vehicle are provided in the detailed estimate.

## **7. A.M.R. METERING SYSTEM**

### **BACKGROUND:**

Puducherry Public Works Department provides water supply in Puducherry urban areas covering Puducherry municipal and Oulgaret municipal areas, part of Vallianur and Ariyankuppam. The main water supply source is from sub surface. The total water extracted from 227 bore wells is 108 mld. There are about 1 lakh house service connection comprising of different categories viz. domestic, non-domestic, institutional, industrial and commercial. At present there is no metered connection and collecting fixed tariff from consumers. Volumetric charging has a significant impact on water usage. Tariffs for higher consumption are telescopic, thereby encouraging water conservation. Therefore, Puducherry PWD has decided to implement AMR metering system to all the categories of water connections.

### **AMR (AUTOMATIC METER READING) WATER METER:**

It is an instrument intended to measure continuously, memorize and display the volume of water passing through the measurement.

### **TYPES OF WATER METER :**

Water meters are manufactured based on electrical or electronic principles and water meters based on mechanical principles incorporating electronic devices used to meter the actual volume of flow of water. The mechanism is calibrated by an adjustable device which is preset and security sealed.

There are three types of meters namely mechanical meters, electromagnetic meters and ultrasonic meters.

Mechanical meters have a proven history of performance and provide viable solution whereas the other meters which are having advanced capabilities / features are still relatively new. Some municipalities and cities in India have installed these mechanical meters.

### **WORKING PRINCIPLE**

Multijet mechanical meter is a turbine type based on velocity of turbine rotation in water.

An impeller is rotated by water passing through the meter, which is translated to a volumetric reading. The mechanism is calibrated security sealed. Cybel sensor added to mechanical meter in all together called as AMR meter.

The walk by / drive by AMR (Automatic Meter Reading) system provides the utility with the ability to read a multi jet type water meter without entering the home. The walk by AMR solution gives the reliable meter readings. The data can be used by the water supplier to provide accurate upto date billing, removing the need for estimated readings on the occasion when access to the meter is not available.

The data can be downloading from the walk by AMR into a hand held terminal or any Android phone. Once the readings have been made the meter reader receives a confirmation message and can move on to the next site.

Alarms will also be sent to the HHT (Hand Hold Terminal)/Android phone in the event of walk by AMR having low battery, or if a tamper is thought to have taken place. Once that data is received it can then be transmitted to cloud data base via GPR or GSM.

Having reaching the cloud data base, the water utility now has the option to use the operating software to produce bill, send customer SMS, customer emails, and generally manage their customer data base.

Both devices (HHT/Android phone) are battery powered and can store around 8 hours of charge. The range ability of the devices typically 300m at a Lime of site. Data storage varies according to type, but it is usually in the range of 10000 meter reads. Having read the meter the data can be sent to the Central Control Room viz GPRS/GPS or wi-fi local net connectivity.

### **ADVANTAGES OF AMR METERS:**

Primary objectives for considering a new metering system include improving the effectiveness of the city's meter reading and customers. AMR can help accomplish these objectives by:

- ❖ Reducing labour and vehicle costs, along with human error associated with routine manual meter reading.
- ❖ Downloading all the meter readings in every billing cycle quickly so bills can be generated rapidly, enabling the city to notify customers proactively about abnormally high consumption.
- ❖ Eliminating the difficulties and risks associated with reading difficult to access meters.
- ❖ Reducing the theft of service by enabling the city to observe evidence of possible theft. (tamper, flags, sudden decrease in consumption between regular billing dates etc.)

- ❖ Creating greater customer awareness of water consumption habits, leading to conservation improvements.

## **PROPOSAL**

It is proposed to fix A.M.R. meters to all the 85,000 House Service connections by considering 73000 connections of 15mm and 12000 connections of 20mm. The total cost for this project works out to Rs.68.32 crore, which includes one year free maintenance during warranty period and also 4 years A.M.C.

### **8.00 DESIGN BASIS REPORT– ELECTRICAL SYSTEM**

#### **1.0.0 GENERAL DESCRIPTION**

This document covers design basis for electricals of **PUDUCHERRY WATER SUPPLY SCHEME AUGUMENTATION** being put up by GOVERNMENT OF PUDUCHERRY PUBLIC WORKS DEPARTMENT, PUBLIC HEALTH DIVISION, and PUDUCHERRY. The Electrical system covered in this document will include 11 KV Substation, 11/0.433 KV Transformer, 11 KV Panels, 415V PCC's, Diesel Generators, Automatic power factor controller panels, Sub panels, , DC System, UPS System, SCADA / PLC, SCADA Flow Station, Indoor and Outdoor Illumination System, LV sandwich Bus duct, Power & Control Cables, GI / FRP Cable Trays, Earthing, Lightning Protection System, LDB's, PDB's UDB's, EDB's.

In the write up furnished below a brief over view of the proposed system, Design Basis & Criteria, Salient features etc. of major equipment have been presented.

#### **2.0.0 SYSTEM DESCRIPTION**

##### **2.1.0 Electrical System :**

The Pondicherry Water Supply Scheme having 3 stages, Bore well, collection well and Master well .

Each Bore Well system Panel Room Comprises of LT Power cum starter panel, LDB and PDB.

Each Collection Well system Comprises of Control Room, DG Room. Control Room Comprises of LT Panel, Scada Panel, Annunciation Panel, UPS Panel,

UPS DB Panel, LDB, PDB and DG Room Comprises of DG Set with Starter panel.

1 No 100KVA Diesel Generator is Located in the Each Collection Well DG room. This 100KVA Diesel Generator is backup Supply for the Motor Control Centre Loads.

Master Well system Comprises of 11KV Substation, Switchgear Room, Control room, Diesel Generator Room. 11 KV Substation Includes the 11KV DP Structure, 1250 KVA Transformer. Switchgear Room Includes 11 KV VCB Panels, LT Panels, DGDB Panels, Capacitor Panel, APFC Panel, DC Charger with DB Panel. Control Room Includes Scada / PLC Panel, UPS Panel, UPSDB, Annunciation Panel. DG Room Includes Diesel Generator and Starter Panel.

1 No 1000 KVA Diesel Generator is Located in the Mater Well area DG room. This 1000 KVA Disel Generator is back up supply for the LT Motor Control Center Loads.

Power requirements at Master well area are created by these transformers through power control center which is located at the the Master Well area switchgear room. DC Charger with inbuilt DCDB located at Master well area switchgear room to serve the control supply to the HT and LT Panels for the control circuits. Single Phase UPS are located in the control room for SCADA backup source. Air conditioner will be provided for UPS Panel. Batteries for UPS and DC System are located in the separated room in the switchgear room.

The Power for the above system will be provided by Puducherry Electricity Board through 11 kvRing Main substation and it will be received at 11 kv level to 11/0.433 KV 1250 KVA Cast resin Type Transformer at Master Well substation.

All the Bore wells can control and monitor from the respective collection well scada system as well as master well scada system. Total system is controlled from Collection well scada, Master well Scada, Pondicherry Metro water Head Quarters as well as locally from respective switchgear.

APFCR Panels also located in the Master well switchgear room and connected to PCC Incomer, main panels to improve the Overall Power factor for the system.

## **SCOPE OF WORK FOR THE ELECTRICAL EQUIPMENT:**

- **ELECTRICAL EQUIPMENT**

The salient features of the system as per concept shall be as follows bus shall not be limited to:

- 1) Providing, installation, testing and commissioning of required LT Panels, Motor Starters with VFD for the all bore well, collection well, Master Well, OHT sump pumps. Operation of motors shall be possible through control panel & PLC System.

- 2) Providing and Installation of LV Motor Capacitor Banks including APFC relays with capacitor panels.
- 3) Panel for Operation of motor operated butterfly valves with all other LV panels and distribution board for other lighting allied loads.
- 4) Providing meters and protection systems with necessary equipments / accessories for protection of motors.
- 5) Local Push button stations near all the motors and valve actuators.
- 6) Providing distribution boards for lighting and other loads.

**Each Pump starter will have.....**

Incoming MCCB of suitable rating  
 Incoming chokes as per VFD manufacturers recommendations  
 VFD of suitable ratings  
 Operator Panel  
 Push Buttons to start from the panel and from remote  
 Indicating Lights for VFD running and trip.

**2.2.0 SAFETY AND ENVIRONMENTAL PROTECTION:**

Safety and environmental protection measures will be incorporated into the pump stations to reduce the risk of an accident such as fire from occurring and to reduce the potential effects should one occur. An overview of these measures is provided in this section. Further details are provided in descriptions of the individual components.

**3.0.0 DESIGN BASIS :**

**3.1.0 SYSTEM DETAILS :**

11 KV SYSTEM	:	3 phase, 3 wire, effectively grounded through resistance
415 V SYSTEM	:	3 phase, 4 wire, effectively grounded.
220 V AC UPS SYSTEM	:	1 phase, 2wire
110 V DC SYSTEM	:	2 wire, Ungrounded

**3.2.0 Codes and Standard**

The Electrical system shall generally conform to the requirements furnished in Indian Electricity Rules, Contract Specifications, Indian Standard Specifications, Codes of Practices, IEEE Standard unless specifically stated otherwise.

**3.3.0 Ambient Conditions**

Design temperature will be considered as 50 Deg C for all electrical equipment.

**3.4.0 Auxiliary Power Supply Voltages**

**3.4.1 Auxiliary power supplies**

Motors rated below 0.2 KW : 240V ± 10 %, 1 phase, AC, 50 HZ. ± 5 %

Motors rater above 0.2 KW HZ. $\pm$ 5 %	:	415V $\pm$ 10 %, 1 phase, AC, 50
Lighting HZ. $\pm$ 5 %	:	240V $\pm$ 10 %, 1 phase, AC, 50
Space Heater HZ. $\pm$ 5 %	:	240V $\pm$ 10 %, 1 phase, AC, 50

### 3.4.2 Control Power Supplies

UPS Supply $\pm$ 0.1 %	:	220V $\pm$ 5 %, 1 phase, AC, 50 HZ.
DC Power Supply	:	110V DC, $\pm$ 10 %

### 3.5.0 Insulation level

#### 11 KV SYSTEM

One minute power frequency withstand voltage	:	28 KV (rms)
1.2 / 50 micro.sec, Impulse withstand voltage	:	75 KV (peak)

### 3.6.0 Short circuit withstanding rating

11 KV Switchgear	:	25 kA for 3 Sec
415 V Switchgear	:	50 kA for 1 Sec

### 3.7.0 Design Margin

Transformer will be sized to take the entire Master well area load during normal & startup condition including starting of largest motor. Necessary diversity factors followed as per standards.

## 4.0.0 SELECTION CRITERIA FOR MAJOR EQUIPMENT AND SYSTEMS

### 4.1.1 11 / 0.433 KV Distribution Transformer

11 / 0.433 KV Transformer will be outdoor, Step down, dry type cast resin Transformers with On Load Tap Changing. Transformer will be rated for 1250 KVA and will be capable of supplying to load as per sequence of operation. Major Technical Particulars of this transformer are furnished below..

a. Capacity	:	1250KVA
b. Voltage Ratio	:	11 / 0.433 KV
c. Vector Group	:	DYn 11
d. Type of Cooling	:	AN
e. On Load Tap Changer	:	HV side + 10% to – 10% in steps of 1.25% each
f. Insulation Class	:	Class B

#### 4.2.0 11 KV RMU Panel& 11 KV Switchboard

The 11 KV RMU Panel will be indoor, Metal clad, Floor Mounted. It Consists of Two Nos of Load Break Switch and 1 No of Vacuum Circuit Breaker. Normally Two Sources available from different substations. Always one source breaker on condition at the same time another source breaker off condition. If any faults/fails in the live breaker, it will get trip automatically and immediately another source breaker will on automatically without any interruption.

The 11 KV Switchboard will be indoor, Metal clad, Floor Mounted, Drawout truck type construction with vacuum circuit breakers. Normally the Incomers will remain closed and the Bus section will remain open, with each feeder taking half load. Manual Changeover will be provided to restore the normal status as well as to carry out planned outage of one of feeders without power interruption as per sequence of operation.

Major Technical Particulars of the switchboard are furnished below.

- a. Type of Switchgear : Metal clad, drawout type, 3 PH, 3 Wire
- b. Voltage : 11 KV
- c. Rated Continuous Current : 1000 A
- d. Short Circuit Withstand : 18.4 kA for 1 sec
- e. System Frequency : 50 Hz

#### 4.3.0 PCC's

Each incomer will be connected to a 11/0.433KV dry type cast resin transformers and will be rated so as to feed the full load of the PCC in the event of failure of other incomer. Normally, the two incomers will remain closed and the bus coupler section will remain open with each feeder taking half load. Manual change over scheme will be provided to restore the normal status as well as to carry out planned outage of one of transformers without power interruption. The MCC will be indoor; metal clad, floor mounting type, with PVC shrouded bus bar and with draw out type feeders.

Major Technical particulars of this MCC are furnished below:

- a. Type of PCC : Fully draw out, Double front, 3 PH, 4 Wire
- b. Voltage : 415 V
- c. Short Circuit withstand : 50 kA for 1 sec
- d. System Frequency : 50 Hz

#### **4.4.0 Cables / Busduct**

##### **4.4.1 Selection criteria:**

The following factors will be considered for selection of cable / Busduct sizes:

- a. Short circuit withstand requirements (only for cables controlled by circuit breakers)
- b. 800 A or above feeder rating will be planned through only sandwiched busducts.
- c. Continuous current rating after applying derating factors due to-
  - Higher ambient temperature
  - Grouping of Cables
  - Higher ground temperature (for cables directly buried)
  - Depth of laying and soil thermal resistivity (for cables directly buried)
- d. Standardization of cable size to minimize number of sizes

##### **4.4.2 11KV Cables**

- a. Incomer cable from RMU Panel to 11KV Switchboard at Master Well Switchgear room.
  - Short circuit current has been considered as 25KA and require withstand time has been considered as 1 sec.
  - Thermal resistivity of soil will be considered as per site condition.
  - Design ambient Temperature will be considered as 50 °C. Corresponding ground temperature has been considered as 40 °C.
- b. Incomer Cable from 11 KV panel to Transformer .
  - Short circuit current has been considered as 25KA and require withstand time has been considered as 1 sec.
  - Thermal resistivity of soil will be considered as per site condition.
  - Design ambient Temperature will be considered as 50 °C. Corresponding ground temperature has been considered as 40 °C.

##### **c. Transformer Cable**

The short circuit withstand time for transformer cables has been considered has 0.2 sec, since the cable will be protected by instantaneous short circuit protection.

- Laying condition has been considered as cable laid in air.
  - Design ambient temperature has been considered as 50°C.
- d. 11kv cable will be 3 core, XLPE insulated, sheathed, armoured and overall PVC Sheathed with standard aluminium conductor. The cable will suitable for earthed system. XLPE insulated cables will be suitable for a continuous conductor temperature of 90°C and short circuit withstand temperature of 250°C. The cable size will be determined as per criteria stated above.

#### 4.4.3 433V Cable/ Busduct

- a. 800 A or above feeder rating will be planned through only sandwiched busducts.
- b. Laying condition for LT cables / Bus ductshas been considered – cable / Busductlaid in air.
- c. Design ambient temperature as been considered - 50°C.
- d. The 433V power cables will have 3, 3.5 or 4 core standard copper/aluminium conductor, having XLPE insulated, PVC sheathed. XLPE insulated cables of voltage grade 1100V suitable for a continuous conductor temperature of 90°C and short circuit withstand temperature of 250°C. The following cable sizes will be standardized after satisfying the cable size criteria. Copper conductor cables – 6mm<sup>2</sup>, 10mm<sup>2</sup>  
Aluminium conductor cables – 16mm<sup>2</sup>, 50mm<sup>2</sup>, 95mm<sup>2</sup>, 185mm<sup>2</sup>, 240mm<sup>2</sup>, 300mm<sup>2</sup>.

#### 4.4.4 Control cable

Controls cable will be multi-core PVC sheathed, steel wire armoured,aluminium cable, PVC insulated with 2.5mm<sup>2</sup> stranded copper conductors. The cables will be of voltage class 1.1KV and generally 3 core, 5 core, 7 core, 19 core, other sizes as required during detailed engineering and control cable will be considered unless specific application requires higher number of cores.

#### 4.5.0 I & C power supplies

##### 4.5.1 110V DC system

The system comprises of 1x100% battery sized for 30 min backup for server, 2x100% float cum boost charges for the battery and DC panel. The system caters for DC power supply of control, protection, interlock, alarm and annunciation of 11KV system & 415 V System

##### **BATTERY**

- a. Voltage : 110V
- b. Type : Nickel – Cadmium
- c. Installation : Indoor
- d. Battery nominal voltage: 1.2 v per cell
- e. Mounting : Wooden racks / steel racks.

### **BATTERY CHARGER**

- a. Input : 415 V AC  $\pm$  10 %
- b. Output : 30 A, 110 V DC
- c. Service : Float cum Boost Charger
- d. Type : Static SCR type full wave fully controlled.
- e. Installation : Indoor

### **Panels / Cubicles :**

- a. Construction : 2mm thick CRCA sheet metal enclosed, dust & vermin proof
- b. Degree of Protection : IP 54 as per IS 2147.

### **4.5.2 110 V AC UPS System**

The system comprises of 2 X 100 % redundant, 220 V 1 PH 50 HZ AC uninterruptible power supply system for the all critical equipments like Server Room, PLC system, UPS system will be fed by the battery and will have a backup time of 30 minutes for server room.

Major Technical particulars of Battery and Battery Charger are furnished below,

### **BATTERY**

- a. Voltage : To suit UPS output voltage requirements
- b. Type : Nickel – Cadmium
- c. Installation : Indoor
- d. Battery nominal voltage: 1.2V per cell
- e. Mounting : Wooden racks / steel racks.

### **CONVERTER CUM CHARGER**

- a. Input : 415 V AC  $\pm$  10 %
- b. Output : To suit UPS Output Requirements
- c. Service : Automatic type with provision for float and boost charging of associated battery bank and also with provision for manual charging.
- d. Type : 6 Pulse, Full wave, Fully controlled
- e. Installation : Indoor
- f. Degree of Protection : IP 41

### **INVERTERS**

- a. Type Control : IGBT Based with High Frequency PWM
- b. Input Voltage : To suit the battery voltage

- c. Output : To suit the requirement
- d. Mode of Operation : Individual and Parallel redundancy
- e. Type : 6 Pulse, Full wave, Fully controlled
- f. Capacity of Inverter : 1 X 100 % & 2 X 100 %

**Panels / Cubicles :**

- c. Construction : 2mm thick CRCA sheet metal enclosed, dust & vermin proof
- d. Degree of Protection : IP 41

**4.6.0 ELECTRICAL SYSTEM PROTECTION:**

At 11 KV Switchgear protection relays will be integrated with respective electrical switchgear panels. The Protections considered for different equipment are as below.

**4.6.1 Incomer Feeders:**

- All relay functions ie Over current / Earth Fault / PT fuse failure, master trip / Auxiliary Relay etc, can also be realized through a single Numerical Relays

**4.6.2 Outgoing Transformer Feeders :**

- All relay functions ie Over current / Earth Fault / PT fuse failure, master trip / Auxiliary Relay etc, can also be realized through a single Numerical Relays

**4.6.3 Auxiliary Relays**

Auxiliary relay / Contactors / Timers for contact multiplication and interlocking should be provide in required Nos. The relay / contact / timers should have sufficient spare contact for future use and interlocking. For Multiplying breaker auxiliary contact, for interlocking purpose electrically set/reset relay shall be used if required.

**4.7.0 Grounding & Lightning protection**

**4.7.1 Grounding System**

A stable grounding system will be provided for grounding of equipment and structures which is essential for the safety of personal as well as to safe guard the equipment under adverse conditions during fault.

The Earthing system design will be carried out as per IS : 3043. Earthing conductor laid above ground will be galvanized steel. Buried earth mat, earth electrodes will be of mild steel. For earth mat design, size of the earthing conductor will be based on maximum fault current for 1 sec. The earthing resistance will be less than 1 Ohm.

All the non-current carrying parts of electrical equipment and metallic structures will be connected to a local earthing network in each area by means of two separate and distinct earth connections. All such local networks will be connected to a common network located on landside. This common network will be connected through earth lead of size 75 X 12 GS strip to earth mat located in main land.

Each Transformer Neutral will be connected to 2 Nos dedicated treated earth pits. This earth pits will be bonded to earth mat.

#### **4.7.2 Lightning Protection System**

A lightning protection system will be provided for Master Well system to protect it against direct lightning strokes in accordance with requirements of IS: 2309.

Lightning Protection system comprises of Vertical Air Terminations (Air Finial), Horizontal air Termination down conductors, test link etc. A separate earthing network will be considered for lightning protection system and this will be connected to dedicated earth electrodes on onshore which in turn will be connected to the buried earth mat on shore.

#### **4.8.0 Illumination and Small Power System**

The Illumination system comprise of normal AC lighting which is 'ON' all the time and Emergency AC Lighting which will be 'ON' from Normal supply through battery charger and from battery in case of Main AC Supply failure.

The illumination level at various working places as well as the type of light fixture to be used will be as per Tender specifications and Drawings.

Illumination system and power receptacles will be fed from Lighting Panels and Power receptacle panels which in turn receive power supply panel from a Lighting Distribution panel at various locations in the plant.

All illumination and small power circuits will be protected by 30 mA rated ELCB's provided at the Incomer of the Each DB's.

Details of various type of Fixtures at Various locations as follows,

1. Outdoor Lighting - SolarType Fixtures
2. Indoor Lighting - LED Type Fixtures

## **INSTRUMENTATION AND SCADA SYSTEM**

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### **1.1.0 GENERAL DESCRIPTION**

This document covers design basis for instrumentation of **PUDUCHERRY WATER SUPPLY SCHEME AUGUMENTATION** being put up by GOVERNMENT OF PUDUCHERRY PUBLIC WORKS DEPARTMENT, PUBLIC HEALTH DIVISION, and PUDUCHERRY. The Instrumentation system covered in this document will include SCADA / PLC, Remote Terminal Unit, UPS System,

Field Instruments like Pressure Transmitter, Level Switch, Flow meter, Pressure Guage..etc...

In the write up furnished below a brief over view of the proposed system, Design Basis & Criteria, Salient features etc. of major equipment have been presented.

### **2.0.0 OBJECTIVE**

The objective of this Design Basis Report (DBR) on Instrumentation and Control System shall be In general, based on the site requirement.

### **3.0.0 DESIGN BASIS REQUIREMENTS**

#### **3.1.0 GENERAL:**

The pumping main system has been designed with an appropriate level of automation to reduce manual intervention by operating personnel and also help to maintain the plant equipment effectively. All the necessary information shall be available for the operating personnel for effective monitoring of the plant parameters. The Collection Well and Master well is provided with its own control room. The control and monitoring of the system is achieved by a stand -alone Programmable Logic Control system with VDU operation console along with required field instrumentation. The Pondicherry Water Supply Scheme having 3 stages, Bore well, collection well and Master well.

The important parameters of the Each Bore Well area can be monitored from Collection Well Control Room. This system interfaced with Main SCADA System through redundant fibre optic cable link for the above monitoring function. Each Bore Well system Panel Room Comprises of Remote Terminal unit.

Each Collection Well system Comprises of SCADA / PLC Panel, UPS Panel, UPSDB. Single Phase UPS are located in the control room for SCADA backup source. Air conditioner will be provided for UPS Panel.

Master Well system Comprises of SCADA / PLC with redundancy, UPS Panel with UPSDB, Annunciation Panel. Single Phase UPS are located in the control room for SCADA backup source. Air conditioner will be provided for UPS Panel.

**All the Bore Well, Collection Well and Master Well motors are all VFD Controlled.**

All the Bore wells can control and monitor from the respective collection well scada system as well as master well scada system. Total system is controlled from Collection well scada, Master well Scada, Pondicherry Metro water Head Quarters as well as locally from respective switchgear.

#### **3.2.0 CODES AND STANDARDS:**

The following applicable codes have been followed for design and engineering :

- IS 3624                      Specification for Pressure and Vacuum Gauges
- ISA S5.2                    Binary Logic Diagram for Process Operation
- IS 1554 ( PART – 1 )      Power Supply Cable

### **3.3.0 POWER SUPPLY:**

The following voltage levels are used for the I & C Systems

- a. PLC / SCADA - 110V AC, 50 Hz, UPS, Single Phase
- b. Field Transmitters ( PT, FT, LT ) - 24V DC, Loop Powered
- c. Input Interrogation Voltage - 24V DC
- d. Panel Lighting - 240V AC, Non UPS, Single Phase

### **3.3.1 VFD DRIVES:**

In this project, we have to use the entire Bore well, Collection well and Master Well Motors are controlled by VFD. In the proportion only mode, the pump speed is proportional to where the water level is within the VFD speed range band.

The VFD speed range band is the range between VFD minimum speed and maximum speed. For example, you may set the VFD minimum speed at 50 % because the pump curve shows that below 50 % speed there is no output from the pump. If the maximum speed is set at 100 % then the VFD speed range is 50 %.

The VFD speed range is spanned where the minimum speed is at the Lead Pump Stop point and the maximum speed is at the last Lag Pump Start set point.

### **3.4.0 BORE WELL SYSTEM:**

The following instruments should be provided in the Each Bore Well area.

- Bore Well Pump Discharge Pressure Indication ( Local Measurement )
- Bore Well Pump Discharge Pressure Switch
- Bore Well Pump Discharge Pressure Transmitter
- Bore Well Level Swith
- Bore Well Pump Discharge flow transmitter to Collection well

All signal cables, Control Cables, Power Cables will be FRLS outer sheath, PVC insulated, armoured, 7-strandard copper conductor cable. For power cable solid conductor is used. The Signal and control cables are individual pair shielded and overall shielded.

### **3.5.0 COLLECTION WELL SYSTEM:**

The following instruments should be provided in the Collection Well System:

- Collection Well Pump Discharge Pressure Indication ( Local Measurement )
- Collection Well Pump Discharge Pressure Switch
- Collection Well Pump Discharge Pressure Transmitter
- Collection Well Level Switch
- Collection Well Pump Discharge flow transmitter to Collection well
- Collection Well Receiving flow transmitter from bore wells.

### 3.6.0 MASTER WELL SYSTEM:

The following instruments should be provided in the Collection Well System:

- Master Well Pump Discharge Pressure Indication ( Local Measurement )
- Master Well Pump Discharge Pressure Switch
- Master Well Pump Discharge Pressure Transmitter
- Master Well Level Switch
- Master Well Pump Discharge flow transmitter to Collection well
- Master Well Receiving flow transmitter from bore wells.

### 3.7.0 SCADA DESIGN BASIS:

#### Aim:

It is proposed to have fail safe operation of the Bore well & Collection well, Master collection sump, Distribution sump & PH's. Pumping station to meet the varied demand of fresh water and raw water in most efficient manner.

The detailed specifications of the equipment proposed to be installed shall be submitted for necessary approval to MWC. The configuration of the system shall adhere to the principles mentioned in this enquiry. Irrespective of the detailed specifications of the respective items detailed in these specifications, the contractor shall be required to provide all equipment, accessories, cabling, earthing, providing necessary transducer / sensors etc.. A PLC system shall be deployed for complete automation. To integrate with the instrumentation work in this contract, the bidder shall provide all electrical and instrumentation systems which can be linked with the PLC system. The instrumentation system shall be able to achieve the objectives listed below.

It is also proposed to have a SCADA based wire / wireless Automation philosophy for the present and future up gradation **of Pump Houses in 6 different zones** to operate the plant in automatic mode and derive the maximum benefits in terms of quality, quantity, trouble-free operation, record data and make available historical data for analysis, reports and identification and traceability.

#### WORKING PHILOSOPHY:

Pumps have to be controlled in such a way that maximum benefits are derived in terms of efficiency and reliability. VFD should be used with each pump system to control to improve energy. VFD's should work by changing output frequency to regulate motor speed according to a programmed demand. By operating the pump at the best efficiency point, the VFD should reduce overall energy consumption, extend pump life and eliminate the need for a power-wasting pressure control valve. Inrush current at start-up should be greatly reduced from 600% full load amps to as low as 115%, reducing stresses on the motor and associated switchgear. VFD should let the station control operate at variable

station discharge pressures. Which should lower the maximum pressure seen on any point in the system thereby reducing leaks by as much as 10%.

System should operate in the “middle” of the pup curve. Control systems should operate only the pumps necessary to meet demand and quickly retire pumps that are no longer required while ensuring that pumps are not short-cycled. Integrator should factor in the pump capacity, availability and run time to autonomously make intelligent decisions about which pumps to use as flow demand increases and decreases. As pressure drops and the system brings on additional pumps, VFD system should accurately compensate for the increased supply by reducing the output speed of the VFD to “cushion” the start of the additional pump.

If a large demand suddenly be placed on the system when the lines are all full, the pump station should react by gradually increasing pressure back to the set point. The PID (Proportional – Integral – Derivative) in a typical control system would ramp too quickly when the pressure is far from the set point, thus using excessive energy, shortening equipment life and possibly damaging the system. System should use a modified PID loop that recognizes the large difference in pressure and gently ramps the system back to set point pressure, quickly enough to maintain the performance of the heads but slow enough to maximize pump life.

By recording and receiving station operation details operators should compare predicted flows to actual flows, determine exactly when and how often pumps are brought online, and make informed adjustments in the program to avoid peak demand.

The SCADA system should offer basic benefits of a traditional SCADA (Supervisory Control and Data Acquisition) system. **Networking source water for all 6 zones to the pump station controller should be made available to the SCADA** via fibre cable. The system should gather data from a wide range of equipment that can be logged. Graphically displayed to show trends, create reports and generate telephone calls on alarm events.

Modbus standard protocol may be used for PLC and Modbus TCP/IP for remote telemetry unit (RTU) applications which should support fibre optic cable.

SCADA should be equipped with data viewing capabilities, trending, Ethernet communications, web server, email alerts, event logging, alarm enunciation and auto-dialler functions – all functions typical of advanced SCADA applications. Multiple secure access levels should be defined for user control who can only view data and who can make changes to the authentication ensures security should be possible.

SCADA should have reporting capabilities. It should be possible to export data to spread sheets for reporting tools to management companies and government agencies or other reports regarding the overall system.

Should a power outage or supply water problem prevent the system from pumping. It is designed to autonomously correct the problem. Not only does the station restart automatically, gently refill the lines and continue pumping, the system logs and communicates the event to the central controller.

#### • **INSTRUMENTATION, AUTOMATION & COMMUNICATION SYSTEM**

System shall be applied with a control panel & RTU housing:

- 1) PLC System: CPU, Memory, Rack, Power Supply, Digital / Analog Input & Output Module, Flow Control station, Program Backup EPROM etc..  
Vendors to consider 1 No spare PLC with program loaded.
- 2) Signal Conditioners, Interrogation Power Supplies, and Interposing Relays etc...
- 3) Operator Panel
- 4) Instrumentation Indicators & recorders for Pressure and Flow
- 5) Control Desk with MMI Panel

#### • **SCADA STATION**

SCADA stations are required at the master Each Collection Well Control rooms, Master Well Control Rooms, Metro Headquarters; all the stations will be monitored and controlled by the SCADA control Station.

SCADA station will be supplied with PC and its accessories, UPS and a Printer at Each Collection Well area, Master Well area and Metro Headquarters.

The entire system is required to read, display, monitor, record the following information from Electrical, Mechanical & Instrumentation Equipment's. The following information may be displayed locally but will have to be sent to SCADA for monitoring and recording.

##### **a) Electrical System:**

- (i) Electrical parameters Like Voltage, Current, kWh, PF at all LT Side 433 V System through RS 485 modbus communication output from multi-function Power Meters.

##### **b) Mechanical Equipment's:**

- (i) Status of all pumps
- (ii) Status (Open / Close) of all Motorized Operated Valves.

**c) Instrumentation Equipment's:**

- (i) Flow data (Instantaneous flow rates / total flow) from the pump house (through flow meter installed at Each Bore Well Discharge side, Each Collection Well Receiving and Sending End, Master Sump Receiving and Sending End, OHT Sump Receiving End.
- (ii) Level of water in the Each Bore Wells, Each Collection Well, Master Sump and OHT Sumps.
- (iii) Pressure at delivery of each pump.

**SCADA includes the following:**

- a. Standardization of instrumentation and control components**
- b. Level Instrumentation**
- c. Pressure Instrumentation**
- d. Power Instrumentation**
- e. Flow Instrumentation**
- f. Instrumentation Power Supplies**
- g. Programmable Logic Controllers**
- h. Operator Interface panel**
- i. Control Strategies**

**3.7.1 STANDARDIZATION OF I&C COMPONENTS:**

Standardization of Instrumentation and Control Components significantly facilitates both operation and maintenance of the stations. With a standard I & C interface, Operators ( both locally and via SCADA ) can quickly adapt to each station and minimum effort or risk of misoperation. Selection of particular I&C component eases maintenance, minimizes “mean time to repair “, and reduces spare parts stock. PLC and SCADA communication components must be standard to facilitate integration of new facilities with minimal work.

**3.7.2 LEVEL INSTRUMENTATION:**

The level instrumentation is very important for starting the each bore well pumps, collection well pumps and Master well pumps. Minimum submersible level to be maintained for all the pumpstart up. Pump will get trip automatically if level goes down below the minimum submerance. All the bore well, collection well and Master well level signals hooked up to the scada for control and monitoring.

### **3.7.3 PRESSURE INSTRUMENTATION:**

Pressure transducers on station discharge header may be appropriate for medium and large pump stations. Pressure switches should be provided for pump high – discharge pressure protection. This is particularly useful to avoid operating pumps with an accidentally shut discharge valve. Pressure switch setting must be determined from the pump manufactures' performance curves. System includes Pressure switch, pressure transmitter and hooked up to respective collection well SCADA as well as master well scada.

### **3.7.4 POWER INSTRUMENTATION:**

Instrumentation and control systems should be 24VDC powered wherever possible. Station main control panels should include 24 V DC batteries and battery charger(s). Batteries should be sealed “valve regulated lead acid” type for optimal safety and minimal risk of acid spillage.

Fusing should be applied to segregate loads. Fuseholders should be blown-fuse-indicating type to further facilitate trouble shooting. Where essential instruments are not available for 24V DC operation, then a 120V AC UPS should be applied, sized for a minimum of one hour operation.

### **3.7.5 FLOW INSTRUMENTATION:**

Flow Measurement considered all the Bore well Discharge Side, Collection well Receiving and Sending end, Master Well Receiving and Sending end. All the flow meters hooked up to respective SCADA System as well as Master Well SCADA System.

### **3.7.6 OPERATOR INTERFACE PANEL:**

The OIP programming should provide alarm annunciation and acknowledgement independently from the SCADA alarm system. Specifically, alarms should remain indicated at the station until acknowledged by a local operator.

Standardization of OIP programming should be required to minimize variations between stations. Screens should be developed from Districts Standard Templates. Alarm and event reporting should follow a standard format. Implementation of trend charts on the OIP is recommended allowing the operator to see the recent performance of the station.

### **3.7.7 SCADA COMMUNICATION:**

Pump stations shall be provided with standard components for SCADA Communications. Minimal risk stations require radio communication only. Medium and high-risk pump stations should be provided with radio communication and telephone company lease –line for backup.

### **3.8.0 FIELD INSTRUMENTS:**

All the field instruments shall be weatherproof type with protection IP-66. The instruments handling shall be provided with diaphragm seals or equivalent to suit our application. The transmitters sensing element and diaphragm seals material will be suitable for water application.

The transmitters shall be two-wired 4-20 mA microprocessor based smart type, hart with local display. The level transmitters used for monitoring the Collection well / Master well level shall be ultrasonic type, two-wire system, loop powered indicator with local display.

All electrical connection to the instruments shall be ½ “ NPT (F)

The field switches shall be snap acting type, SPDT, hermitically sealed, gold plated potential free contacts with minimum contact rating of 230 V AC, 5A.

